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Case No. 433.01
Project No. TM-231
Ref. Sym: 1612-(14[illegible])

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MR. L. A. DUNN, 1284

Re: Ramp Test of T-315 Container

TCG-NNT-1

Summary of Results

A T-315 container carrying a dummy Mk 9 weapon was tested on the engineering test ramp in accordance with test requirements specified in SCS-5. Ten tests were run with ramp dolly impact velocities ranging from 3.7 to 7.1 miles per hour and with only minor damage to the container incurred. On several of the higher velocity impacts the shear pads deformed sufficiently to allow the weapon to strike the edge of the projectile base container box, but no damage resulted. Movement of the projectile base and fuze containers in the box due to impact caused them to become dented in the areas which struck the spacer plate separating them. No other damage was sustained by the T-315 container or the Mk 9 weapon during the test.

Acceleration measurements were recorded for the ramp dolly, the container, and the weapon. The maximum shock accelerations measured were as follows: 31.1 g aft on the ramp dolly with a 3-millisecond rise time and a 12-millisecond pulse duration and 76.1 g aft on the container base with a 3-millisecond rise time and a 5-millisecond pulse duration, both measured for a 6.6 mph impact; and 22.3 g aft on the weapon (near C.G.) with a 20-millisecond rise time and a 35-millisecond pulse duration measured for a 7.1 mph impact.

Displacements of the container base with respect to the dolly floor had maximum values of 0.18 in. forward and 1.84 in. aft. Maximum displacements of the weapon nose with respect to the container were 2.50 in. forward, 1.42 in. aft, 0.84 in. upward, and 1.28 in. downward.

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Object of Test

The object of this test was to perform an engineering test ramp impact test on a T-315 container carrying a dummy Mk 9 weapon in accordance with shipment test requirements specified in SCS-5. Impact velocities were requested by the consultant to be obtained within 0.3 mph of the specified values for velocities up to 7.0 mph and between 7.0 and 7.4 mph for that value. Further objectives were to record impact accelerations received by the ramp dolly, container, and weapon at selected locations and to measure relative displacements between the container and dolly and between the weapon and container at specified points.

T-315
2-5

Reason for Test

This container test was requested in a Work Order Authorization from L. A. Dunn, 1284 to Division 1612, dated August 17, 1954. Mr. N. E. Hill, 1284, was the test consultant.

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Summary of Past Tests

No previous dynamic tests have been run on the T-315 container.

Setup for Test

The T-315 container given the ramp test is shown in Fig. 1 and has the Assembly Drawing No. DS(1284)34320 and Serial No. 2. The Mk 9 training unit shown in Fig. 2 was assembled with the following components which bore no Serial Nos.: windshield - MC-95, Dwg. No. F110456; body assembly - MC-92, Dwg. No. C110435; closing plug assembly - MC-89, Dwg. No. 110452.

An inert nose fuze, MC-98, Dwg. No. 110461, in an H-120 container, Dwg. No. 111434, and a projectile base, MC-119, Dwg. No. 110467, in an H-121 container, Dwg. No. 111435 were carried in the projectile base container box of the T-315 container.

Instruments and recording equipment employed to test the T-315 container on the engineering test ramp included the following:

6 Statham accelerometers (Figs. 1, 3, 4, 5, 6, 7 and Table I)
2 Scriber-plate displacement gages (Figs. 5, 7)
8 Hathaway amplifiers, Type MRC-21C, Serial Nos. 5492-3, -4, -5, -7, -15, -16, -17, -18
Hathaway instrument oscillator, Type MRC-21, Serial No. 5492-2
Miller recording oscillograph, Model H, Serial No. 161
Miller power supply, Type JP110, Serial No. 21
Hathaway power supply, Type PSA-21, Serial No. 19
Ramp dolly velocity gage (Fig. 8)

Figure 9 shows the test ramp with the T-315 container on the ramp dolly drawn up the ramp in position for a test run. The dolly stop and a wood block, upon which the dolly bumper impacted, are shown in Fig. 10.

Procedure

The engineering test ramp and the ramp dolly are pictured in Fig. 5. In order to simulate approximately shocks encountered in railroad freight car handling, the dolly is allowed to roll down the inclined section of the track and then run along the level track and impact upon some suitable material mounted on the ramp stop. The magnitude, duration, and waveform of the impact shock received by the dolly when it impacts are dependent upon the impact velocity, determined by the release height of the dolly on the incline, the type of material attached to the bumper, and the thickness of the material. For tests on the T-315 container, the 6600-lb. dolly with its approximately 1000-lb. load, (T-315 container - 350-lb., Mk 9 weapon - 650-lb.), was allowed to impact upon one or two 4 x 4 in. pine blocks the depth of the dolly bumper in length.

The bumper and one block mounted on the ramp stop are shown in Fig. 10. The figure also shows the distance of dolly rebound during a trial test run with a 5.3 mph impact.

In order to obtain the dolly impact velocities specified for ramp tests in SCS-5 within the limits requested by the consultant, ten test runs were conducted. Data relative to each run, i.e., dolly release position, number of wood impact blocks, and impact velocity obtained, are given in Table II.

Accelerations were measured on the ramp dolly, container, and weapon at the locations listed in Table I and illustrated in Figs. 1, 3, 4, 5, 6, and 7. Relative displacements of the base of the container, with respect to the ramp dolly floor, were measured in the longitudinal direction. Displacements of the nose of the weapon, with respect to the base of the container, were measured in the longitudinal and vertical directions. The Scriber-plate displacement gages used to make these measurements are shown in Figs. 5 and 7.

The impact velocities of the ramp dolly were measured with a velocity gage consisting of two physical contact arms mounted on the side of the track a known distance apart and a microswitch attached to the side of the dolly. The switch was actuated as it passed over the contact arms and energized a circuit which was connected to the recording oscillograph providing a record of the times at which the switch touched the contact arms. The gage is pictured in Fig. 8. The gage length shown for which average velocities were computed was 4.04 ft.

Following each test run, the consultant of Division 1284 inspected the shear pin between the chock support base of the container and the weapon for evidence of yielding and also the projectile base container box and the under side of the windshield of the weapon for evidence of the windshield having struck the box.

Results

Inspections by the consultant of Division 1284 found evidence that the under side of the windshield of the weapon struck the edge of the projectile base container box during several (see Table II) of the higher velocity impacts of the ramp dolly. No damage resulted, although paint was scraped from the weapon and box in the areas of contact. Movement of the projectile base and fuze containers in the container box due to shock resulted in the containers becoming dented in the areas which struck the spacer plate separating them. No other damage was sustained by the T-315 container or the Mk 9 weapon during the test.

The impact velocities obtained on the various ramp test runs are listed in Table II and plotted in Fig. 11.

The acceleration records taken during the ramp tests were analyzed separately for impact shock and vibration data. The forms of the accelerations generally experienced at each of the locations of measurement are illustrated in the sample test record shown in Fig. 12. The acceleration signatures all were faired to eliminate vibration frequencies greater than about 200 cps since the consultant requested only data in the range from 0 to 150 cps. The vibration data derived from the test records are presented in Table III.

The shock accelerations observed in the test records were analyzed according to the method outlined in SOS-10, i.e., maximum acceleration magnitudes measured were the maximum faired values, rise times were times between accelerations of 10 percent and 90 percent of the maximum faired values, and pulse durations measured were the times between accelerations of 50 percent of the maximum faired values on pulse build-ups and the same magnitudes on pulse fall-offs. The shock data produced by this analysis are tabulated in Table IV. The shock acceleration magnitudes are plotted versus impact velocity for the dolly, container, and weapon in Fig. 13, although average shock pulse durations at the three locations were not the same value.

The low values of the maximum accelerations measured on the container and dolly shown on Fig. 13 for the 5 to 6 mph and the 6.9 and 7.1 mph impacts are due to the waveforms of the shocks being considerably different for those tests than for the rest of them. Although maximum magnitudes were smaller, relatively speaking, longer pulse durations resulted in relatively more energy in each of these shocks, so that plots of shock pulse energy vs impact velocity would likely be nearly linear functions.

The relative displacement measurements made between the container base and the dolly floor were recorded to determine the amount of movement of the container that was allowed by the shoring and tie-down system during each run. The measurements made between the nose of the weapon and the container base were recorded to determine approximately the amount of movement of the forward section of the weapon on the shear pads under shock. It was desired to measure clearances between the under side of the weapon windshield and the projectile base container box during the acceleration. However, complex movement of the weapon including a rotation made this clearance measurement from the displacement gage records impossible. The actual relative displacements of the nose of the weapon in the longitudinal and vertical directions, which were measured from the test records, are tabulated along with the container longitudinal relative displacements in Table V. Figure 14 is a photostatic copy of the displacement gage records obtained at the two locations of measurement for one test run. Abnormally deep indentations of the displacement gage scriber on the recording plate of the weapon nose gage in parts of the record shown and in parts of other test records indicate that some

lateral movement of the nose of the weapon occurred during the tests for which they were recorded. The relative positions of nose of the weapon and the projectile base container box of the T-315 container and the maximum displacement of the nose measured during the test are illustrated to scale in Fig. 15.

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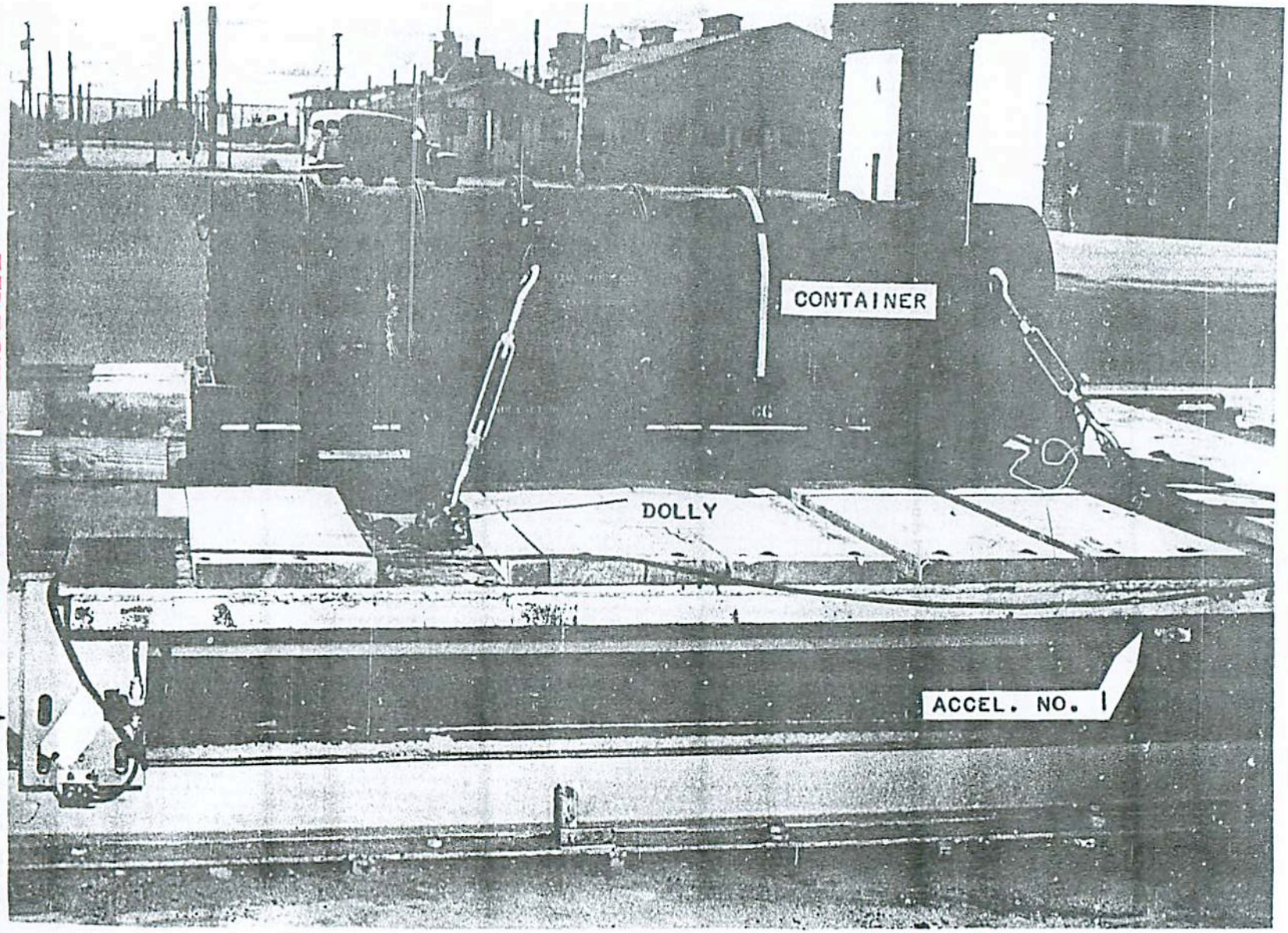

FIG. 1 - THE T-315 CONTAINER ON RAMP DOLLY (FOLLOWING TEST)
RAMP TEST OF T-315 CONTAINER

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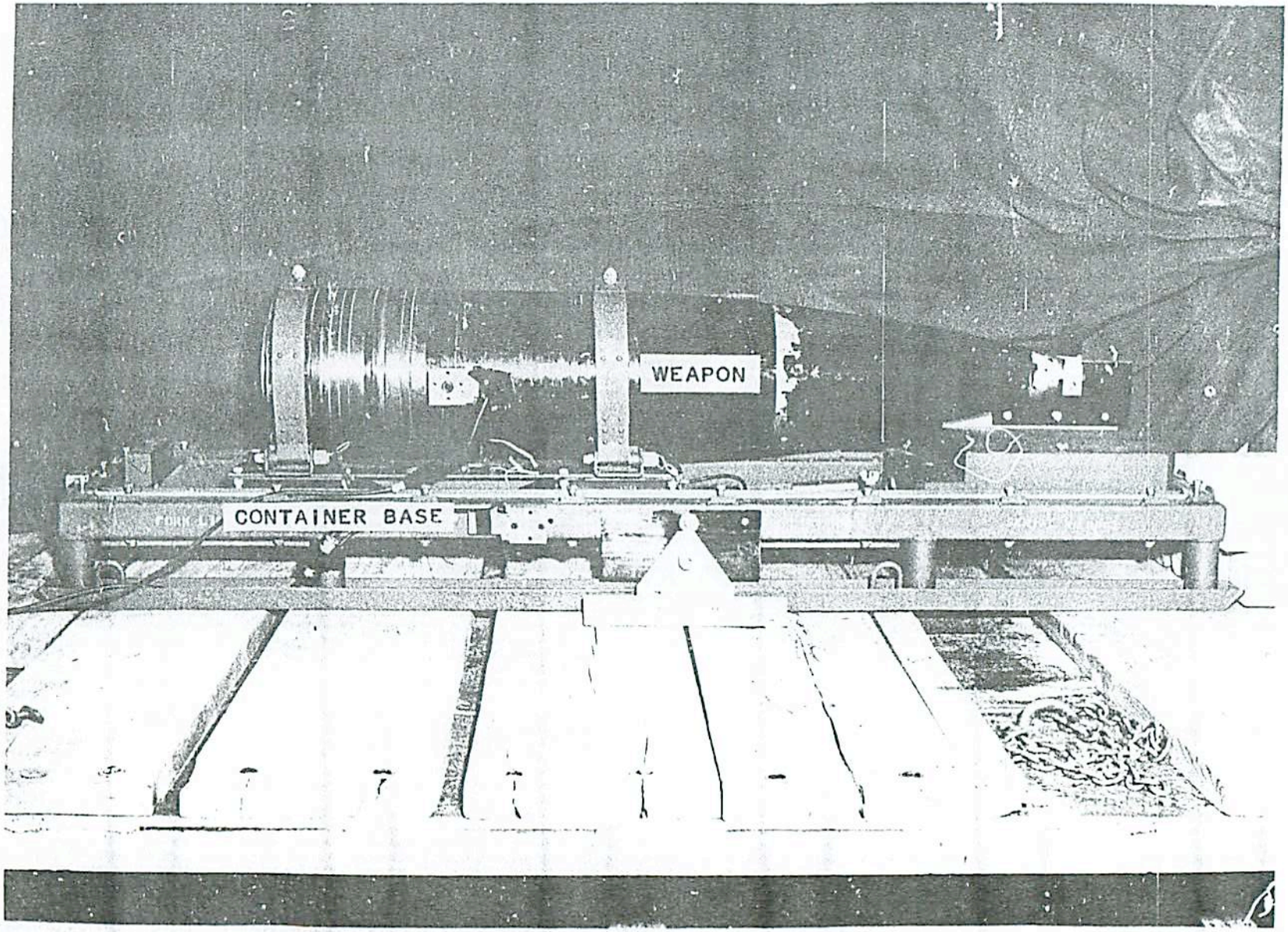

FIG. 2 - MK 9 WEAPON MOUNTED ON T-315 CONTAINER BASE
RAMP TEST OF T-315 CONTAINER

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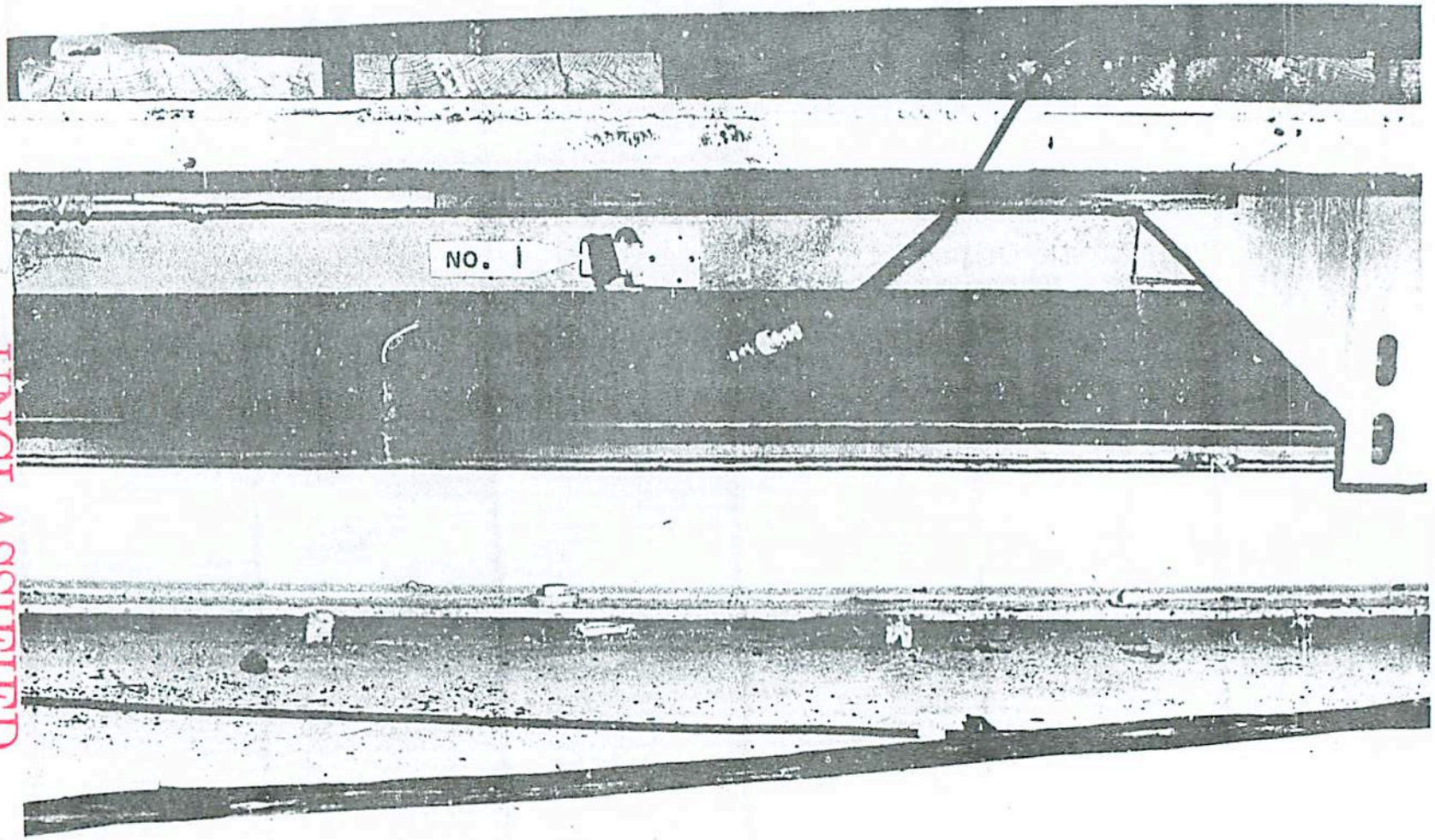

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FIG. 3 - ACCELEROMETER ON RAMP DOLLY
RAMP TEST OF T-315 CONTAINER

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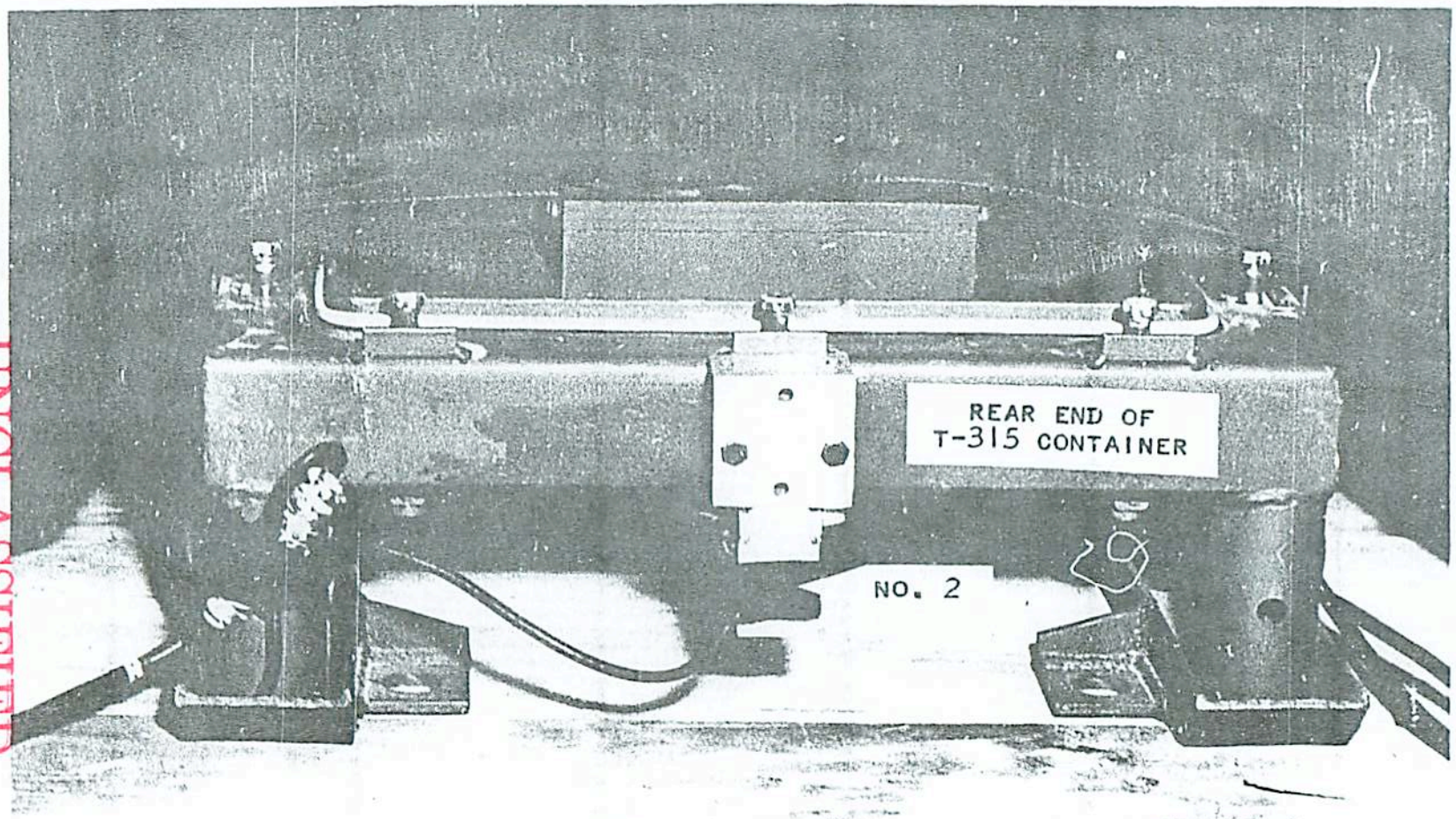

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FIG. 4 - ACCELEROMETER ON T-315 CONTAINER
RAMP TEST OF T-315 CONTAINER

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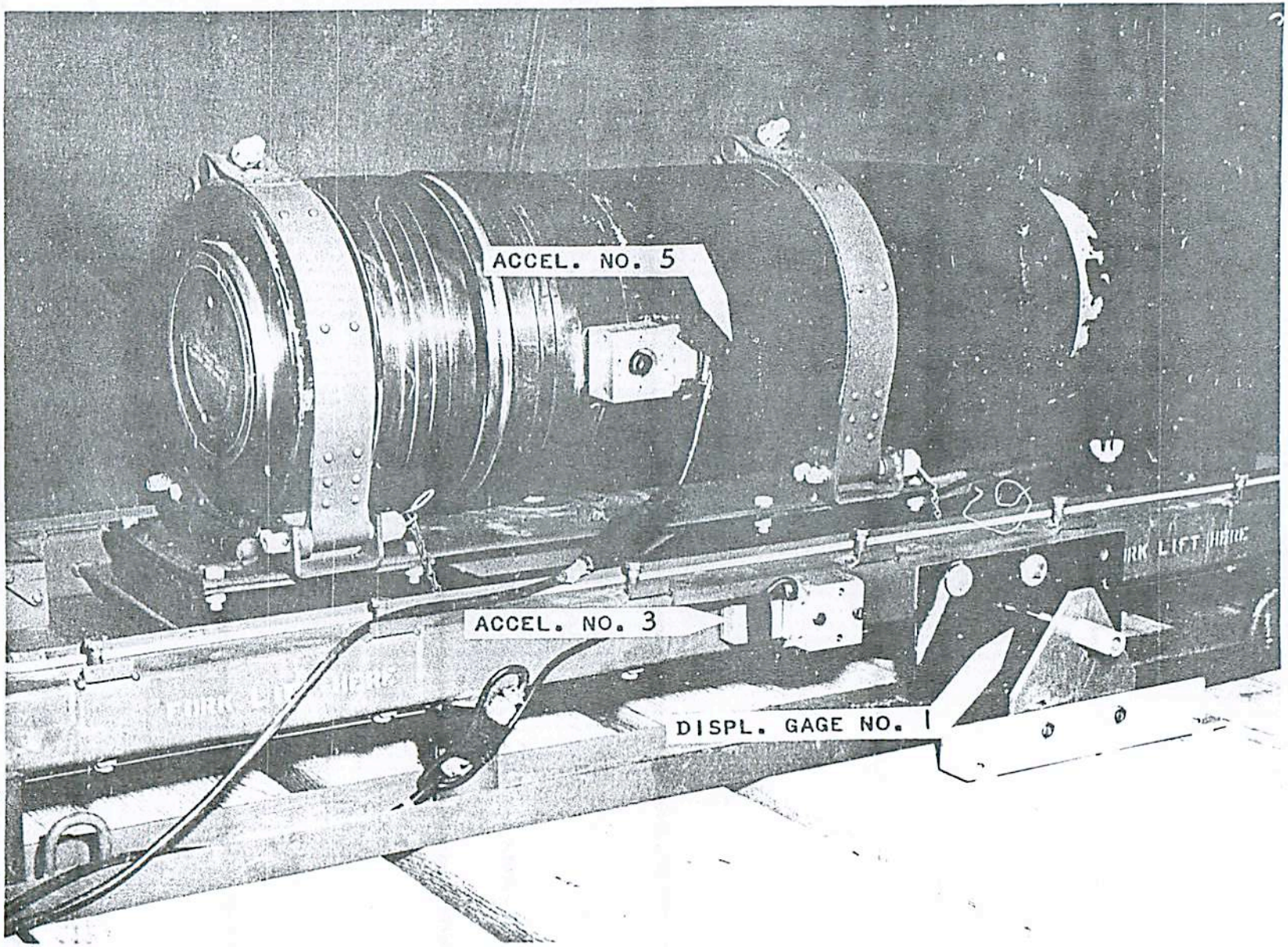

FIG. 5 - INSTRUMENTS ON T-315 CONTAINER AND MK 9 WEAPON
RAMP TEST OF T-315 CONTAINER

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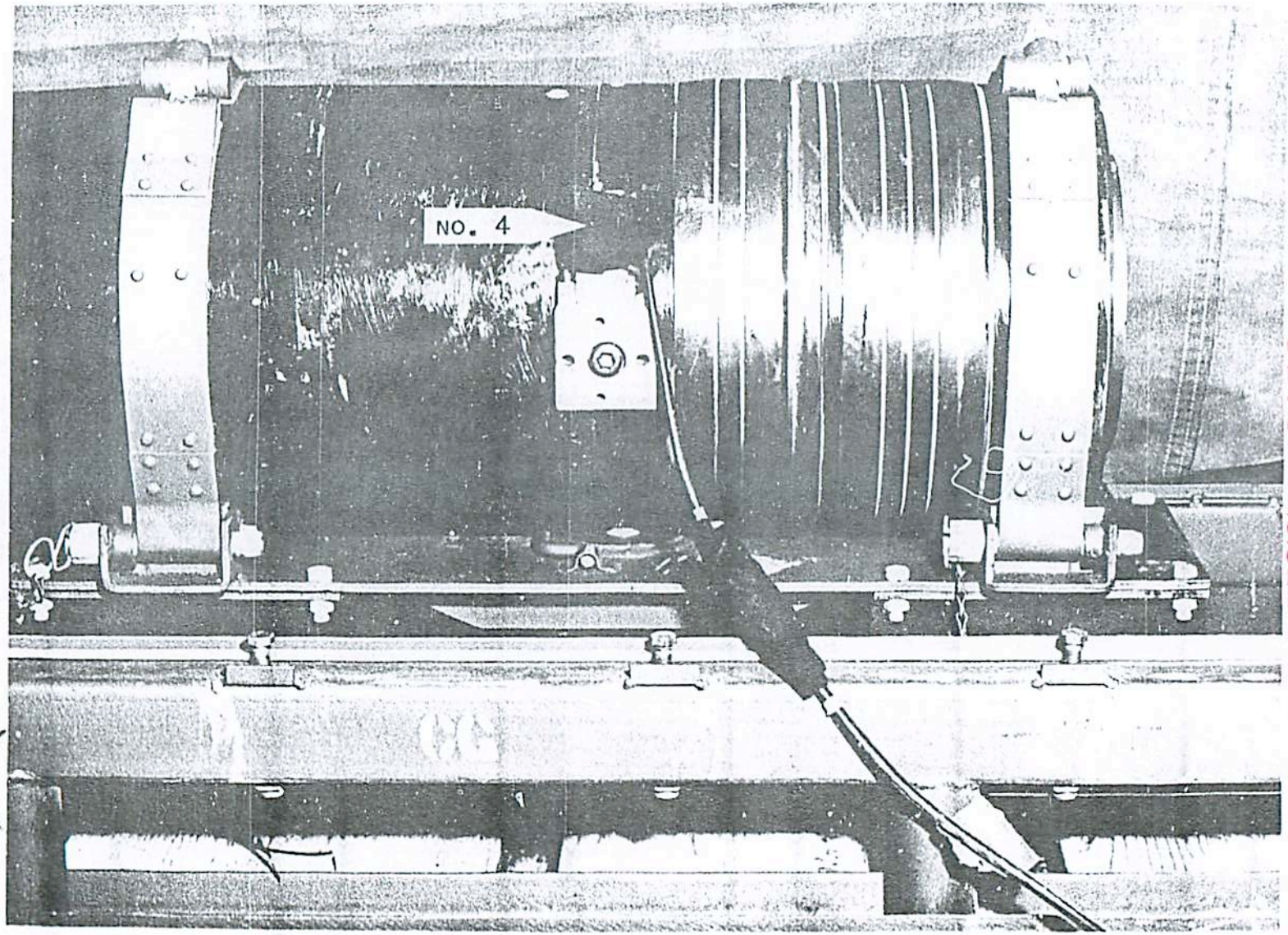

FIG. 6 - ACCELEROMETER ON MK 9 WEAPON
RAMP TEST OF T-315 CONTAINER

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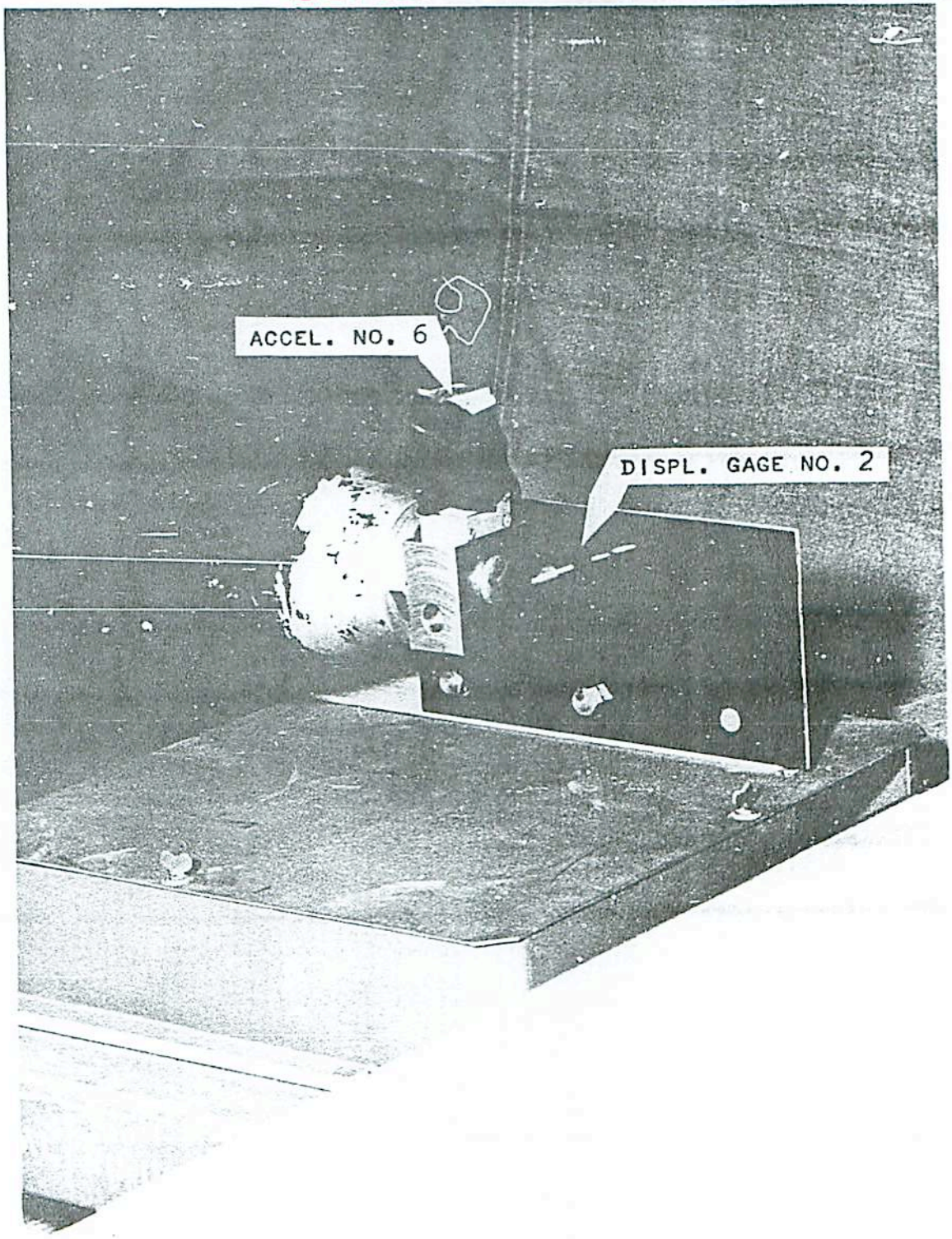

FIG. 7 - INSTRUMENTS ON NOSE OF MK 9 WEAPON RAMP TEST OF T-315 CONTAINER

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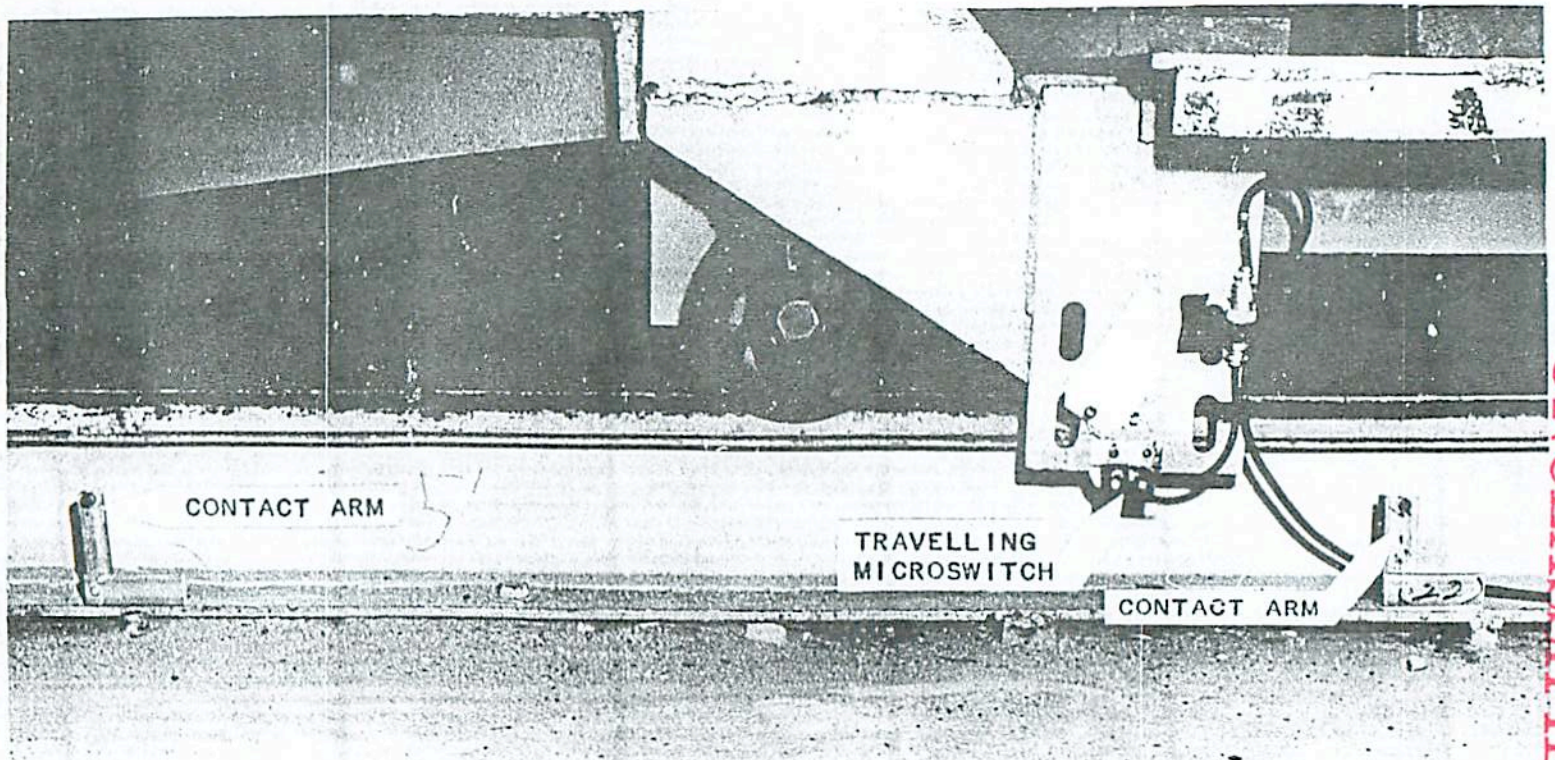

FIG. 8 - RAMP DOLLY VELOCITY GAGE
RAMP TEST OF T-315 CONTAINER

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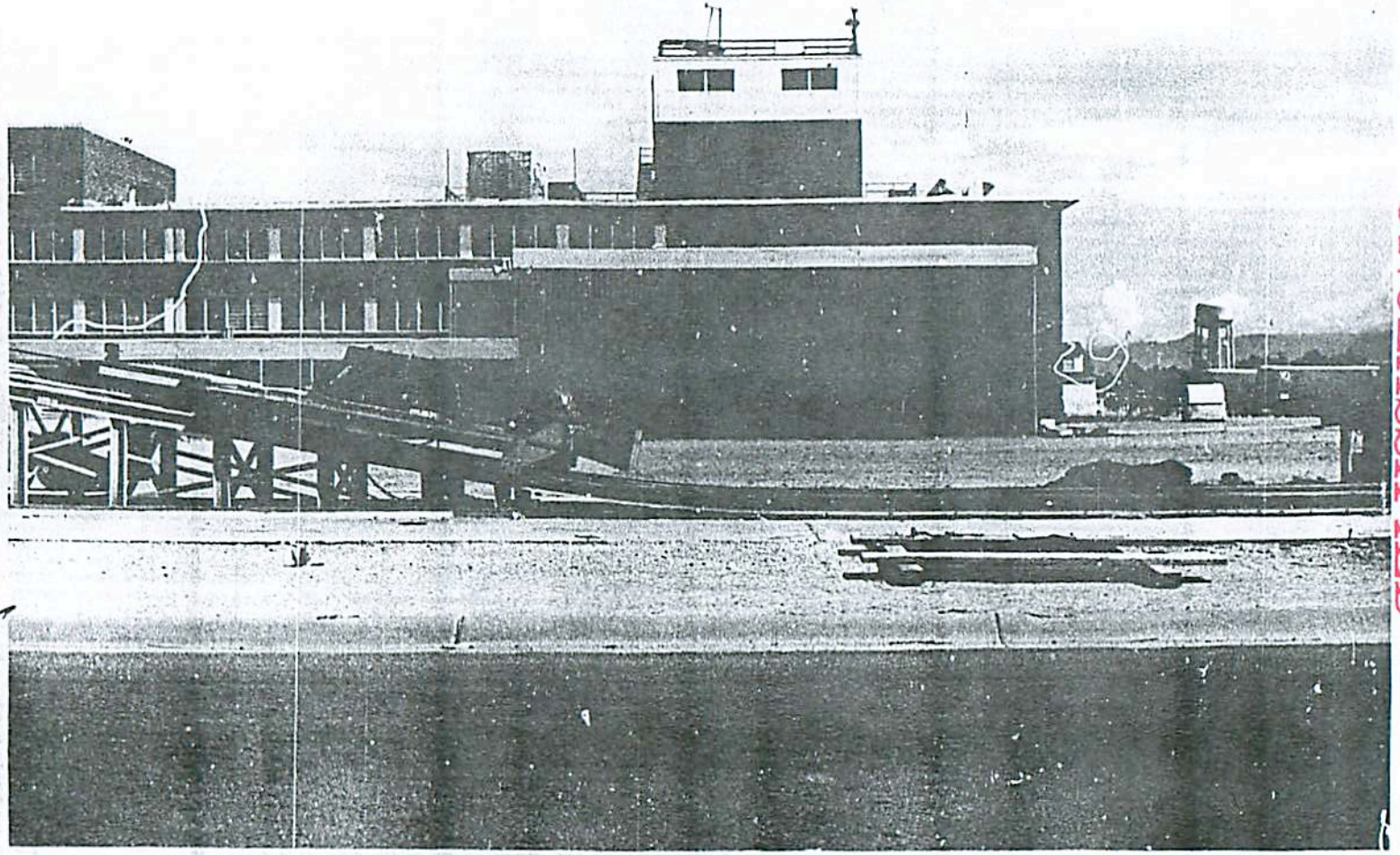

FIG. 9 - RAMP DOLLY WITH T-315 CONTAINER ON RAMP INCLINE IN POSITION FOR TEST RUN. RAMP TEST OF T-315 CONTAINER.

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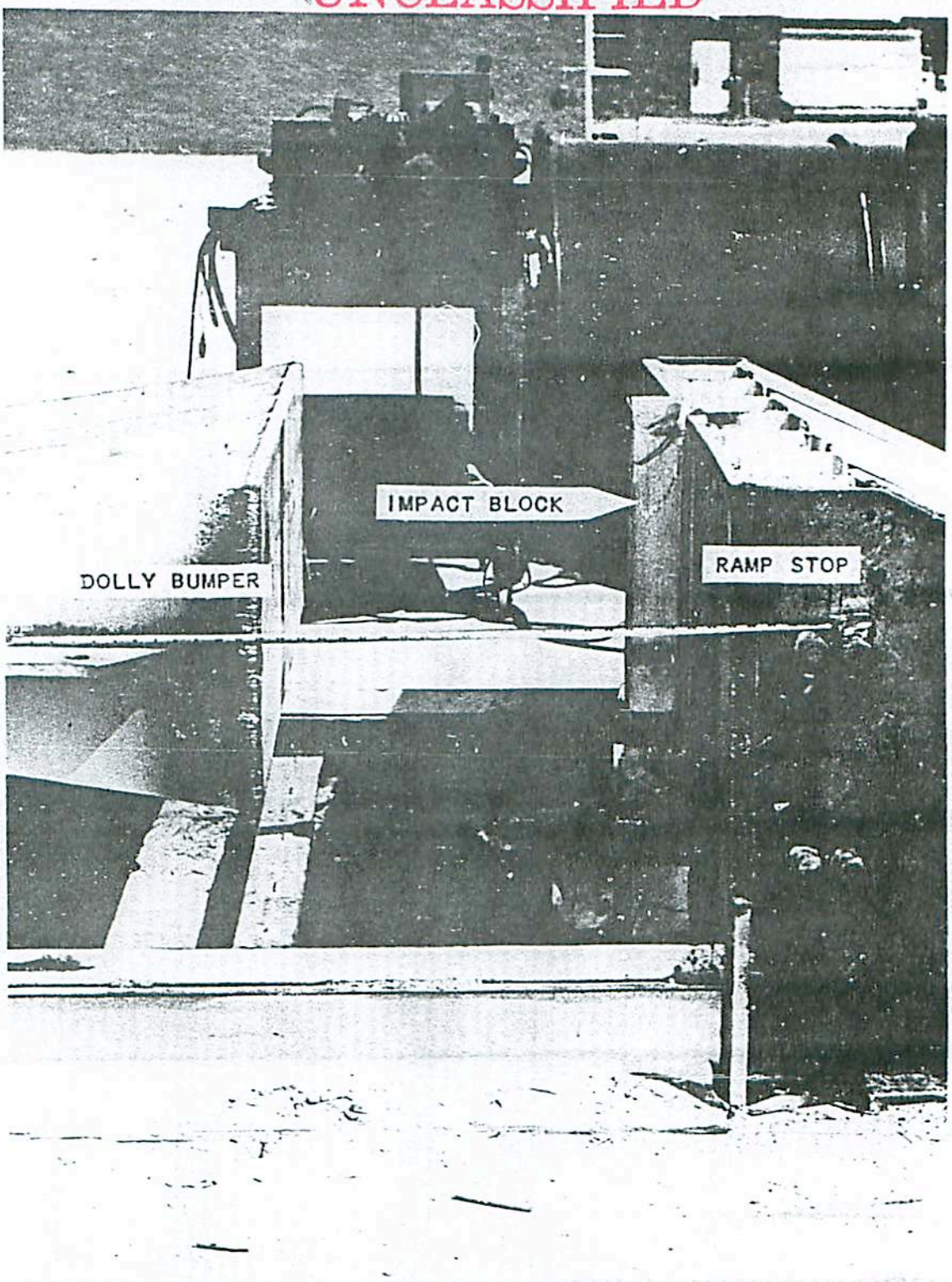

FIG. 10 - RAMP STOP AND IMPACT BLOCK
RAMP TEST OF T-315 CONTAINER

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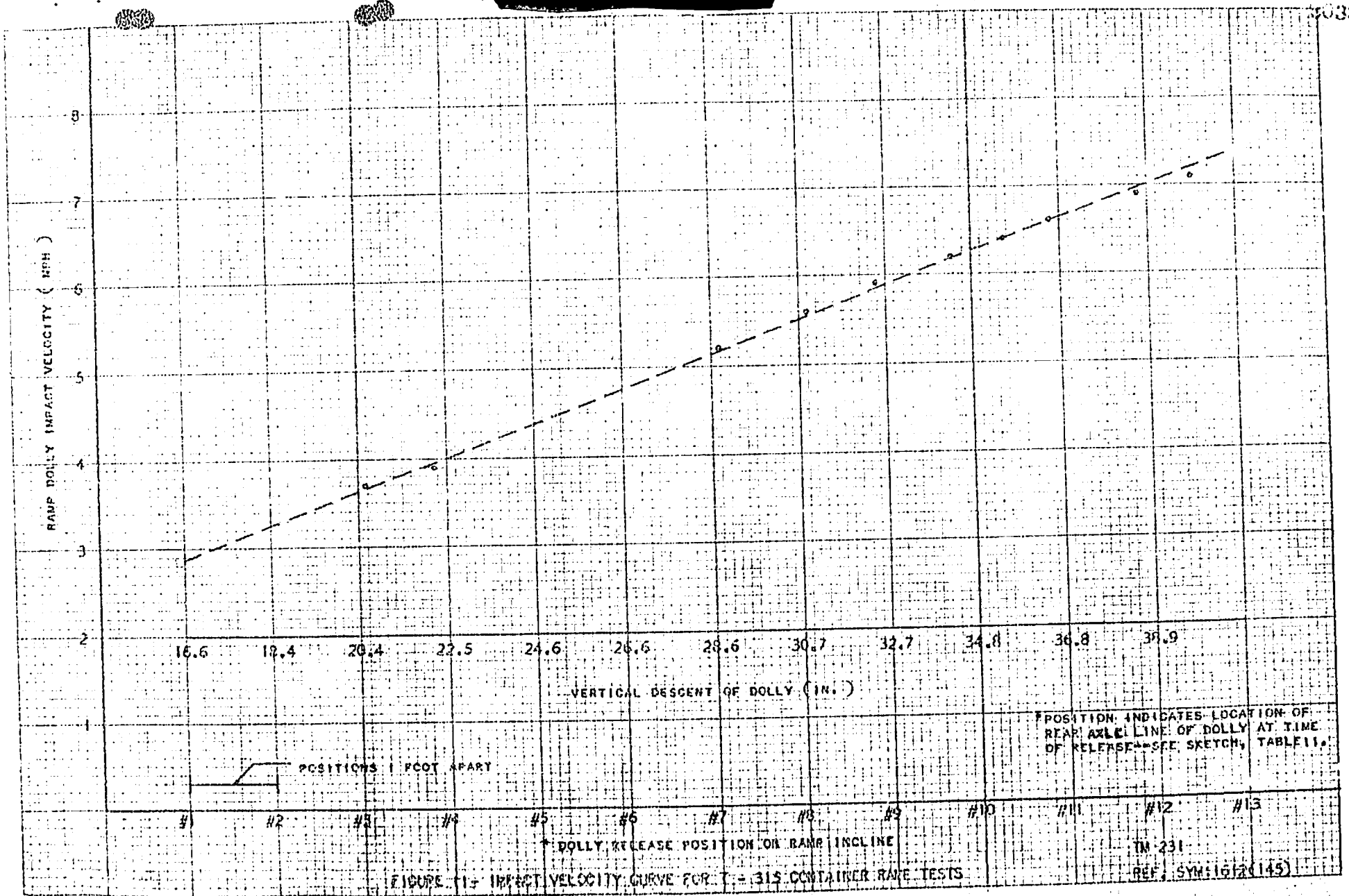

FIGURE 11- IMPACT VELOCITY CURVE FOR T = 315 CONTAINER RAMP TESTS

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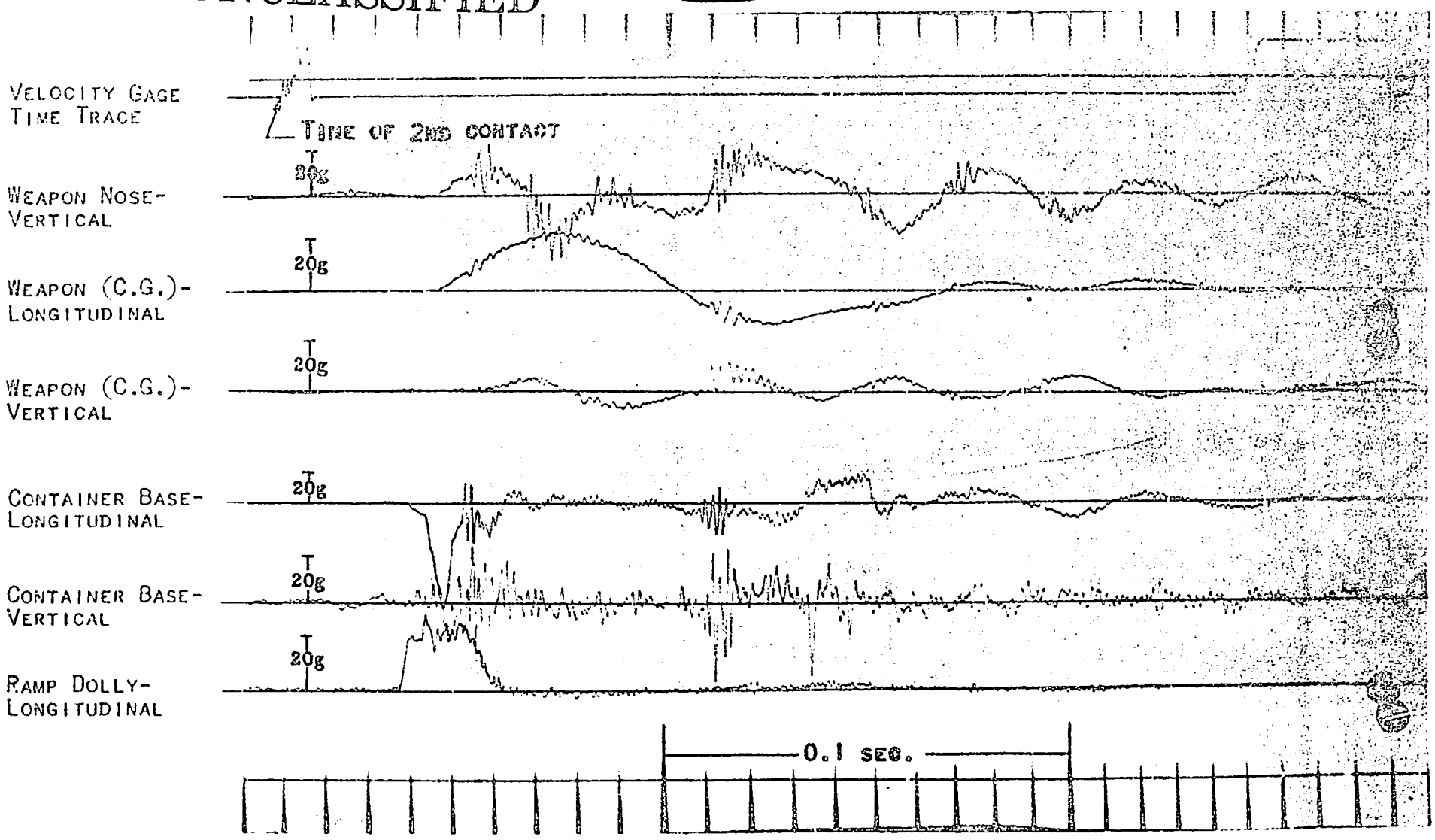

FIG. 12 - ACCELERATION RECORD TAKEN DURING RUN 10, 7.1 MPH IMPACT RAMP TEST OF T-315 CONTAINER

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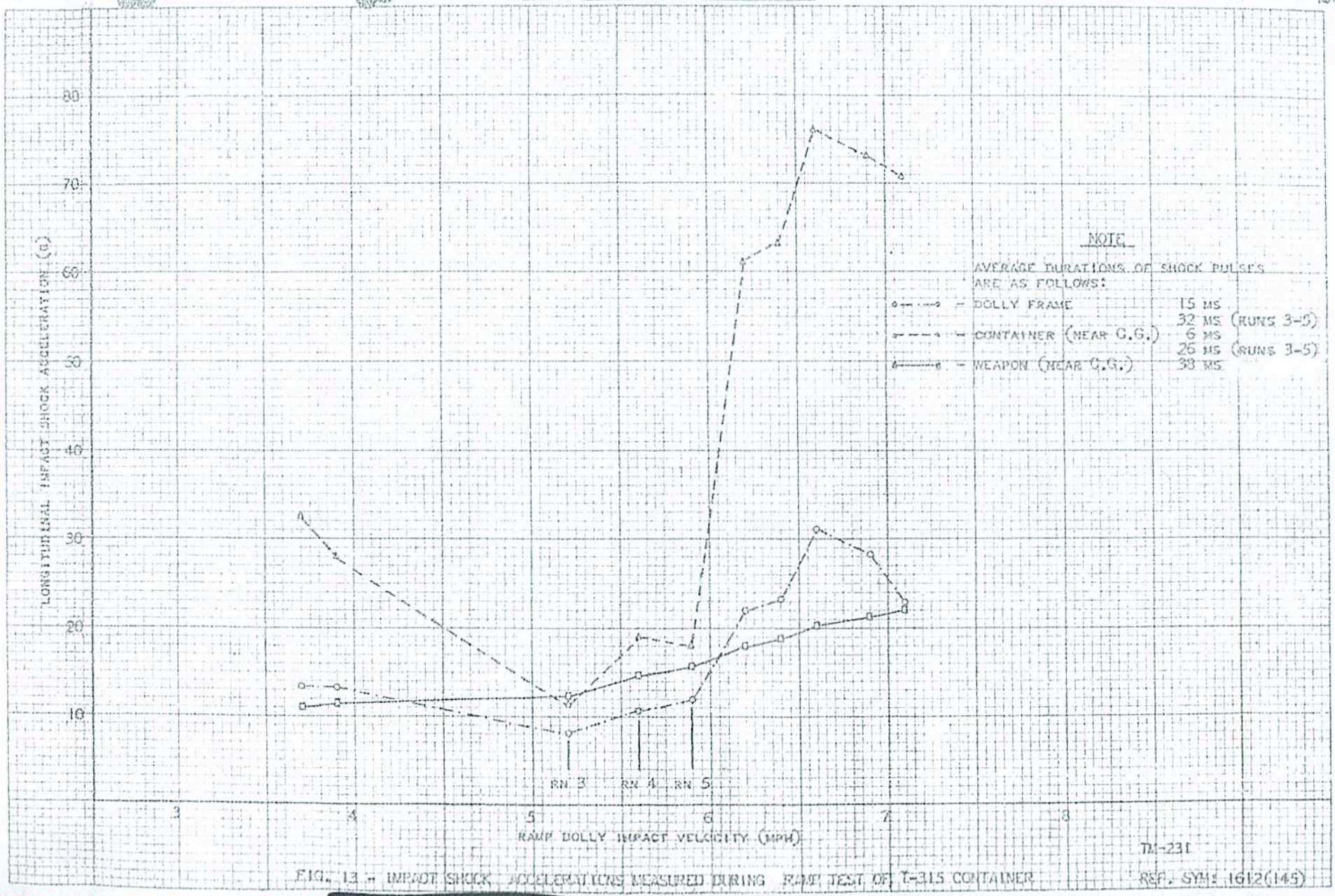

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FIG. 13 - IMPACT SHOCK ACCELERATIONS MEASURED DURING RAMP TEST OF T-315 CONTAINER

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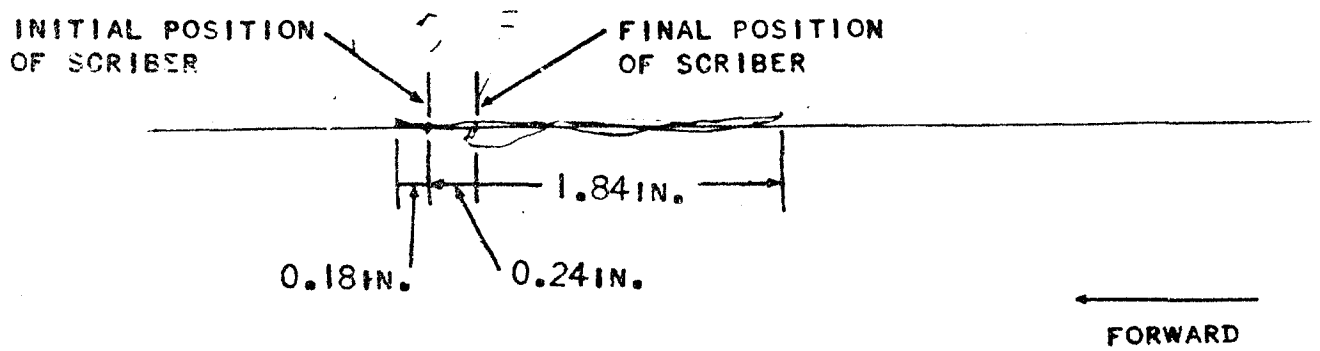
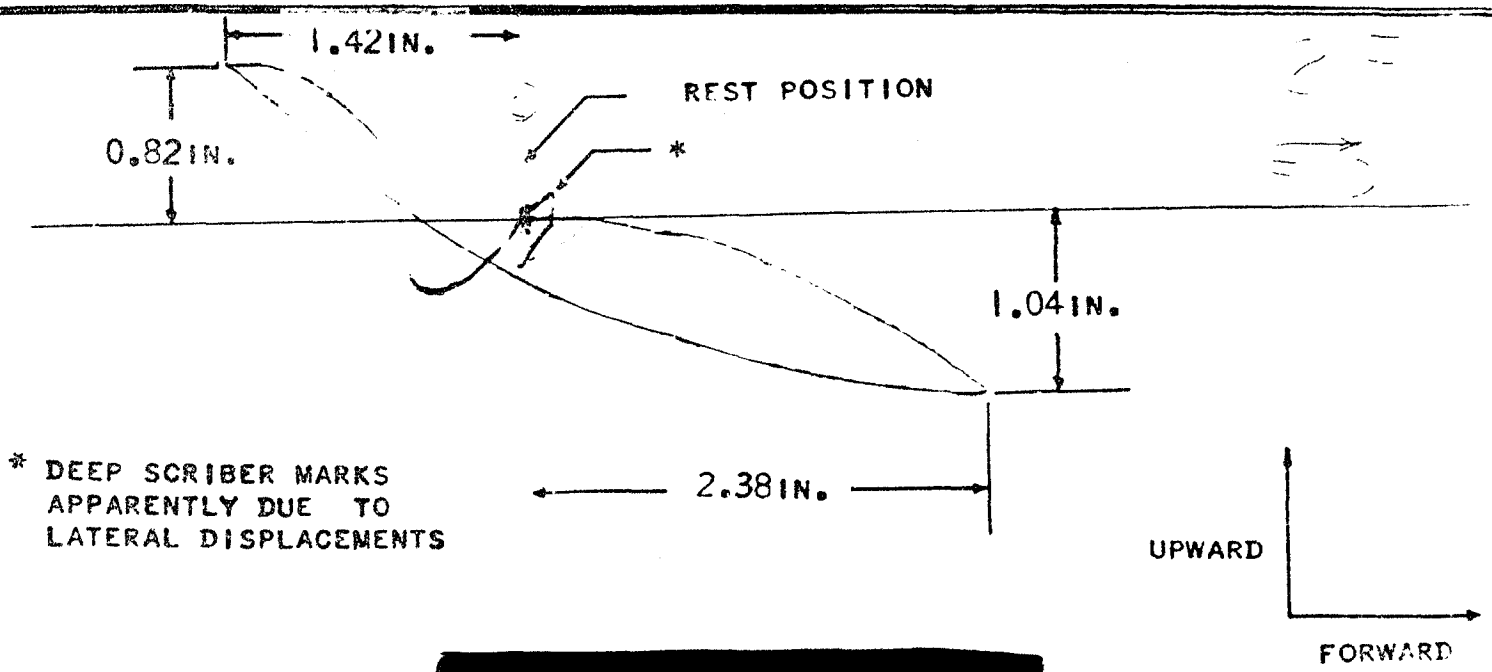


GAGE NO. 1 - LONGITUDINAL RELATIVE DISPLACEMENT OF CONTAINER BASE WITH RESPECT TO RAMP DOLLY FLOOR.



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GAGE NO. 2 - LONGITUDINAL AND VERTICAL RELATIVE DISPLACEMENT OF WEAPON NOSE WITH RESPECT TO CONTAINER BASE.

FIG. 14 - RELATIVE DISPLACEMENT GAGE RECORDS OBTAINED DURING RUN 10, 7.1 MPH IMPACT.
RAMP TEST OF T-315 CONTAINER

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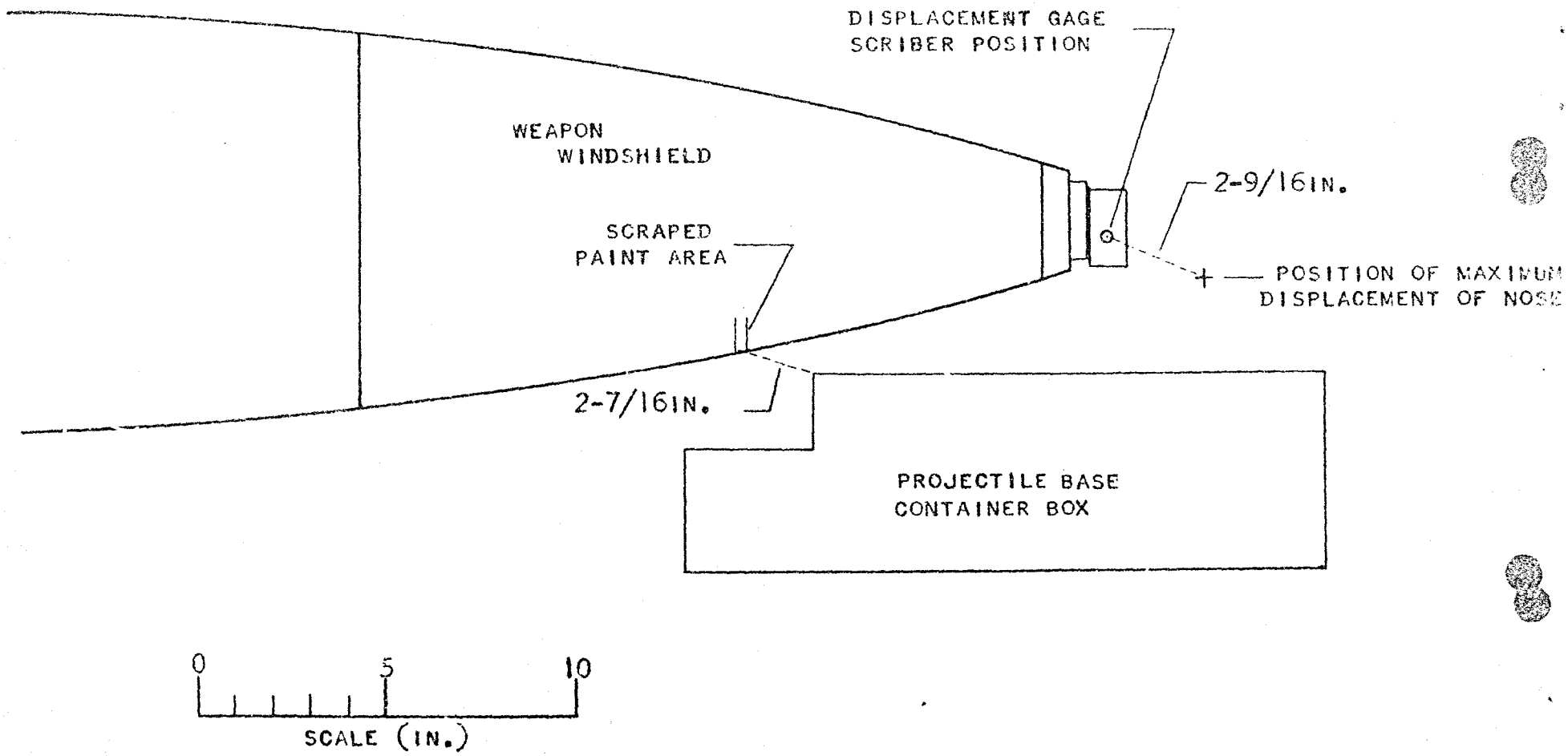

FIG. 15 - RELATIVE POSITION OF WINDSHIELD OF MK 9 WEAPON AND PROJECTILE BASE CONTAINER BOX OF T-315 CONTAINER. RAMP TEST OF T-315 CONTAINER.

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Project No. TM-231
Ref. Sym: 1612-(145)

TABLE I

Accelerometer Data

Ramp Test T-315 Container

Gage No.	Location	Direction	Serial No.	Range (g)	Natural Freq. (cps)	Model No.
1	Dolly Frame	Longitudinal	275	± 50	550	A5A-50-240
2	Container Base Frame	Vertical	284	± 50	580	A5A-50-240
3	Container Base Frame (near C.G.)	Longitudinal	279	± 50	560	A5A-50-240
4	Weapon (near C.G.)	Vertical	280	± 50	600	A5A-50-240
5	Weapon (near C.G.)	Longitudinal	274	± 50	550	A5A-50-240
6	Weapon Nose	Vertical	278	± 50	590	A5A-50-240

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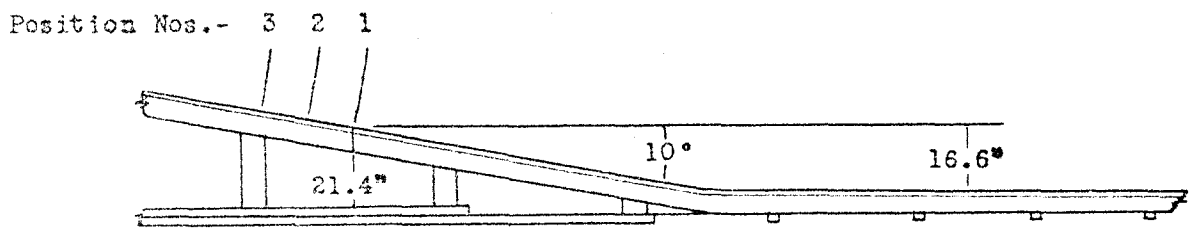
TABLE II

T-315 CONTAINER RAMP TEST INFORMATION

Run Number	*Dolly Release Position	Impact Velocity (mph)	No. Impact Blocks	Remarks
1	#3 + 1-3/16 in.	3.7	1	
2	#6 + 10-3/4 in.	3.9	1	
3	#7 + 1-3/16 in.	5.2	1	
4	#8 + 1-1/8 in.	5.6	1	
5	#8 + 10-3/16 in.	5.9	1	
6	#9 + 9-5/8 in.	6.2	2	Windshield of weapon struck edge of projectile base container box of T-3 during runs 6 throu 10
7	#10 + 4-7/16 in.	6.4	2	
8	#10 + 11 in.	6.6	2	
9	#11 + 11-1/2 in.	6.9	2	
10	#12 + 6 in.	7.1	2	

* Refer to sketch below. Positions shown refer to the locations of the rear axle line of the ramp dolly. The distance between positions is one foot.



Section of Engineering Test Ramp

TABLE III

Vibration Accelerations Measured During Ramp Test of T-315 Container

Gage No.	Location and Direction	Run No. and Impact Velocity	*Frequency (cps)	**Max. Pk.-Pk. Accel. (g)	◊Max. + Accel. (g)	Max. - Accel. (g)	Run No. and Impact Velocity	Frequency (cps)	Max. Pk.-Pk. Accel. (g)	Max. + Accel. (g)	Max. - Accel. (g)	Frequency (cps)	Max. Pk.-Pk. Accel. (g)	Max. + Accel. (g)	Max. - Accel. (g)
2	Container Base - Vertical	1	91	8.2	2.6	5.6	6	51	10.8	4.9	5.9	77	10.8	6.1	4.[illegible]
3	Container Base - Longitudinal		74	8.3	2.6	5.7		31	12.1	7.4	4.7	102	9.7	6.8	9.[illegible]
4	Weapon (C.G.) - Vertical	3.7 mph	24	8.9	4.0	4.9	6.2 mph	20	11.8	5.4	6.4	26	9.8	3.4	6.[illegible]
6	Weapon Nose - Vertical		15	26.3	14.0	12.3		18	22.5	7.5	14.1	23	18.8	11.0	7.[illegible]
6			22	22.0	14.0	8.0		64	34.5	20.4	14.1				
2	Container Base - Vertical	2	95	8.7	4.2	4.5	7	72	10.1	3.0	7.1	77	--	6.3	--
3	Container Base - Longitudinal		72	8.4	2.4	6.0		23	17.6	8.3	9.3	87	13.9	4.7	9.[illegible]
4	Weapon (C.G.) - Vertical	3.9 mph	24	9.4	3.7	5.7	6.4 mph	21	10.2	5.4	4.8	29	7.7	2.9	4.[illegible]
6	Weapon Nose - Vertical		15	24.9	12.2	12.7		22	23.5	12.2	11.3	29	22.2	7.1	15.[illegible]
6			23	19.1	12.2	6.9		77	--	23.8	--				
2	Container Base - Vertical	3	87	14.2	6.0	8.2	8	44	15.8	7.0	8.8	87	13.1	6.3	6.[illegible]
2			120	9.7	7.7	6.8									
3	Container Base - Longitudinal							22	--	6.5	--	23	16.4	5.6	10.[illegible]
4	Weapon (C.G.) - Vertical	5.2 mph	27	11.1	5.3	5.8	6.6 mph	20	11.5	5.7	5.8	29	9.6	3.8	5.[illegible]
6	Weapon Nose - Vertical		15	20.1	9.6	10.5	Gage 5	23	--	1.4	4.6	Gage 6 15	39.3	22.1	17.[illegible]
6			23	16.4	9.6	6.8		20	38.4	27.1	16.2	23	35.7	19.5	25.[illegible]
2	Container Base - Vertical	4	71	--	--	5.7	9	60	11.20	5.3	5.9	78	--	--	9.[illegible]
2			65	11.0	6.1	4.9		80	--	9.4	--	87	14.2	8.3	5.[illegible]
3	Container Base - Longitudinal	5.6 mph	24	13.5	6.8	6.7	6.9 mph	25	15.6	8.8	9.8				
4	Weapon (C.G.) - Vertical		24	10.6	5.2	5.4		21	12.0	5.6	6.4	23	10.6	5.6	5.[illegible]
6	Weapon Nose - Vertical		15	25.5	13.4	12.1		19	33.1	13.5	19.6	23	27.0	14.7	12.[illegible]
			23	23.2	13.4	9.8									
2	Container Base - Vertical	5	87	8.9	4.0	4.9	10	65	--	2.6	--	80	12.5	5.2	7.[illegible]
2			36	7.0	2.6	4.5		125	13.6	8.7	4.9				
3	Container Base - Longitudinal	5.9 mph	24	12.5	6.4	6.0	7.1 mph	20	17.7	8.3	9.4	100	11.6	8.3	3.[illegible]
3								143	11.7	5.0	6.7				
4	Weapon (C.G.) - Vertical		25	10.2	3.8	6.4		21	12.6	5.5	7.1	27	9.0	3.2	5.[illegible]
6	Weapon Nose - Vertical		14	24.2	10.1	14.1		15	37.7	16.2	21.5	23	25.4	16.2	9.[illegible]
6			26	11.8	6.6	5.2		65	--	21.1	--				

* Average values

** All acceleration magnitudes are faired values

◊ Directions of + accelerations are upward and forward

TABLE IV

Shock Accelerations Measured During Ramp Test of T-315 Container

Gage No.	Location & Direction	Run No. & Impact Velocity	* Max Accel. (g)	Rise Time (ms)	Pulse Duration (ms)	Run No. & Impact Velocity	Max. Accel. (g)	Rise Time (ms)	Pulse Duration (ms)
1	Dolly Frame - Longitudinal	1	-13.5	3	14	6	-22.3	1	16
3	Container Base - Longitudinal		-32.5	11	8		-61.4	6	5
3		3.7 mph	12.9	11	10	6.2 mph	11.3	13	11
5	Weapon (C.G.) - Longitudinal		-11.2	17	36		-18.4	18	37
1	Dolly Frame - Longitudinal	2	-13.5	2	16	7	-23.5	1	15
3	Container Base - Longitudinal		-28.0	9	8		-63.3	4	5
3		3.9 mph	12.7	9	10	6.4 mph	14.7	11	11
5	Weapon (C.G.) - Longitudinal		-11.9	17	36		-19.0	20	37
1	Dolly Frame - Longitudinal	3	- 8.3	1	36	8	-31.1	3	12
3	Container Base - Longitudinal		-11.5	4	32		-76.1	3	5
3		5.2 mph	14.4	8	10	6.6 mph	17.1	8	13
5	Weapon (C.G.) - Longitudinal		-12.4	27	41		-20.6	18	38
1	Dolly Frame - Longitudinal	4	-10.9	5	29	9	-28.5	2	14
3	Container Base - Longitudinal		-19.2	7	24		-73.4	4	5
3		5.6 mph	13.7	8	10	6.9 mph	15.4	10	12
5	Weapon (C.G.) - Longitudinal		-14.8	24	40		-21.2	18	38
1	Dolly Frame - Longitudinal	5	-12.1	2	31	10	-22.8	2	19
3	Container Base - Longitudinal		-18.1	6	22		-70.9	4	4
3		5.9 mph	13.4	11	10	7.1 mph	17.3	11	14
5	Weapon (C.G.) - Longitudinal		-15.9	24	40		-22.3	20	35

* All acceleration data are for faired acceleration records analyzed according to procedure specified in SCS-10 outlined on page 4 of this report. The direction of + accelerations is forward.

TABLE V

Relative Displacement Measurements
Ramp Test of T-315 Container

Gage No. 1 - Longitudinal Relative Displacement Between T-315 Container and Ramp Dolly Floor

Run No.	Impact Velocity (mph)	Max. Fwd. Displ. (in)	Max. Aft. Displ. (in)	Rest Pos. (aft.) (in)
1	3.7	.18	.80	.40
2	3.9	.12	.82	.36
3	5.2	.12	1.14	.60
4	5.6	.10	1.08	.06
5	5.9	.10	1.10	.14
6	6.2	.14	1.12	0
7	6.4	.14	1.42	0
8	6.6	.14	1.84	0
9	6.9	.16	1.40	.22
10	7.1	.18	1.84	.24

Gage No. 2 - Longitudinal and Vertical Relative Displacement Between Weapon Nose and T-315 Container

Run No.	Impact Velocity (mph)	Max. Fwd. Displ. (in)	Max. Aft. Displ. (in)	Max. Upward Displ. (in)	Max. Downward Displ. (in)
1	3.7	1.26	.70	.54	.62
2	3.9	1.32	.82	.52	.70
3	5.2	1.42	.82	.60	.68
4	5.6	1.74	1.04	.70	.86
5	5.9	1.82	1.08	.68	.96
6	6.2	2.22	1.32	.76	.98
7	6.4	2.26	1.26	.78	1.04
8	6.6	2.42	1.42	.84	1.08
9	6.9	2.50	1.42	.84	1.28
10	7.1	2.38	1.42	.82	1.04

Note: Displacements generally are accurate to within ± .02 in.